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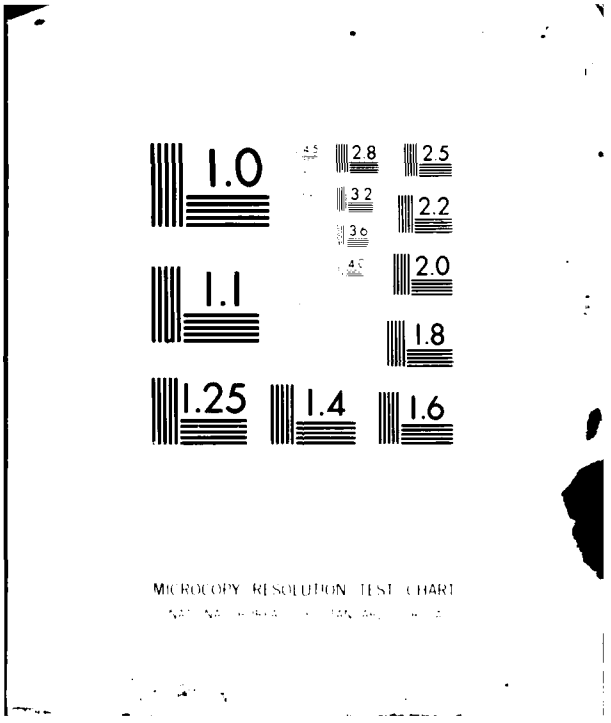
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SETTLEMENT OF FOULING ORGANISMS AT THE HMAS STIRLING RAFT SITE

John A. Lewis

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ABSTRACT

The settlement of fouling organisms on non-toxic panels was studied over a twelve-month period on a new marine exposure raft at HMAS STIRLING in Cockburn Sound, Western Australia. Monthly settlement counts for the six major organisms and water temperature measurements indicated that the raft met the criteria of Australian Standard 1580, test method 481.5 in these respects, as required for registration by the National Association of Testing Authorities (NATA). Larval settlement occurred throughout the year and water temperatures are within the range prescribed by the standard. Species which settled on the panels represented each of the major groups of fouling organisms. Panels immersed for twelve months were initially dominated by algae but these were subsequently displaced by barnacles, ascidians and bivalve molluscs.

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16. *ABSTRACT (If this is security classified, the announcement of this report will be similarly classified):*

The settlement of fouling organisms on non-toxic panels was studied over a twelve-month period on a new marine exposure raft at HMAS STIRLING in Cockburn Sound, Western Australia. Monthly settlement counts for the six major organisms and water temperature measurements indicated that the raft met the criteria of Australian Standard 1580, test method 481.5 in these respects, as required for registration by the National Association of Testing Authorities (NATA). Larval settlement occurred throughout the year and water temperatures are within the range prescribed by the standard. Species which settled on the panels represented each of the major groups of fouling organisms. Panels immersed for twelve months were initially dominated by algae but these were subsequently displaced by barnacles, ascidians and bivalve molluscs.

CONTENTS

SETTLEMENT OF FOULING ORGANISMS AT THE HMAS STIRLING RAFT SITE

1. INTRODUCTION

A raft designed to test underwater coating systems under static conditions was positioned at the Western Australia Naval Support Facility HMAS STIRLING in mid-1978 (Figure 1). Registration of the raft by the National Association of Testing Authorities (NATA) requires the raft and raft site to meet the criteria specified by Australian Standard 1580, test-method 481.5 [1]. Data on the settlement of fouling organisms and variation in surface water temperatures over a twelve-month period form part of this requirement.

Fouling settlement at the raft site was studied by personnel at HMAS STIRLING during 1978-79 to obtain data necessary for NATA acceptance of the site. However, a review of this programme showed that HMAS STIRLING had neither the equipment nor the suitably trained personnel to provide the required data. In 1979, DTRIALS therefore requested MRL to undertake a study to obtain these data. The results of this study are contained herein, together with data from the preliminary study, for comparison.

2. METHODS

2.1 Nata Registration Study (1979-80)

Twelve black unplasticized poly(vinyl chloride) (PVC) panels (30 cm x 15 cm x 3 mm), each sandblasted and identified by plastics numerals, were supplied to HMAS STIRLING for the trial. The first of these was attached to the raft on 31 May, 1979. Panels were then immersed for successive periods of one month. After removal from the raft, each panel was preserved in a formalin-seawater solution, heat-sealed in a plastics covering and returned to MRL. Water temperature was measured about 10 cm below the surface in the near vicinity of the raft.

To obtain settlement counts of the principal fouling organisms, as prescribed by AS1580, test-method 481.5 [1], all species within an area of dimensions 10 cm x 10 cm on the front (the face directed north on the raft) of the panels were identified and counted.

2.2 Preliminary Study (1978-79)

Grey PVC panels (30 cm x 15 cm x 6 mm) were immersed for successive periods of one month over an eleven month period. Panels were not sand-blasted prior to immersion. After removal, fouling type and abundance were assessed qualitatively by personnel at HMAS STIRLING. In addition the development of fouling on three panels immersed for the entire period was monitored at monthly intervals. At the completion of the trial, all panels and recorded observations were given to MRL for detailed assessment. Panels were quantitatively assessed using the same methods as in the NATA registration study.

3. RESULTS

3.1 Nata Registration Study (1979-80)

The monthly settlement counts of the six most numerous animals are presented in the format prescribed by AS1580, test method 481.5 in Table 1. Due to unavoidable circumstances, the tenth panel in the series could not be removed on schedule and remained on the raft for two months. One-month counts for March and April were therefore estimated from the total settlement during the two-month period. The method of estimation was to determine the possible values which best fitted a curve drawn to connect February and May counts. The resultant values provide a guide to settlement intensity during the interjacent months.

Enteromorpha sp. (a green alga) and several species of ectocarpoid (brown algae) were the dominant fouling organisms during the study period. However, these plants had a fine mat-like growth form in which individual plants could not be readily distinguished. Settlement counts are therefore not a suitable means of assessment and the abundance of these species cannot be included under the format of Table 1.

Three barnacle species settled on the panels: *Balanus trigonus* Darwin, *B. amphitrite amphitrite* Darwin and *B. variegatus* Darwin. Juvenile specimens could not be distinguished readily and combined settlement counts are therefore given. However, *B. trigonus* was easily the dominant species, *B. variegatus* common but at much lower densities than *B. trigonus*, and *B. amphitrite amphitrite* the rarest of the three.

All six major animal fouling organisms show considerable variation in abundance through the year and several do not settle during some months. Despite this variation, overall fouling settlement continues throughout the year. Forty-two species of fouling organism were identified on test panels (Table 2) and these represent all of the principal fouling groups. Tube-dwelling amphipods also frequently colonised the panels but no attempt was made to identify these species.

The maximum recorded water temperature was 26.5°C in December; the minimum 14°C in August (Figure 2).

3.2 Preliminary Study (1978-79)

Settlement counts of the six most numerous organisms on panels immersed for periods of one month during the preliminary study are presented in Table 3. Counts are markedly lower than those recorded during our study in the following twelve months.

The development of the fouling community on the panels immersed for twelve months is illustrated in Figure 3. Panels were initially dominated by algae. After four months these were displaced by tubeworms, barnacles, bryozoa and the bivalve *Mytilus edulis* Linnaeus. Later in the year ascidians and another bivalve, *Monia ione* Gray, established themselves within the community and became codominants with *M. edulis*. The biomass of the various components after twelve months is shown in Table 4.

4. DISCUSSION

4.1 Comparison of Results with AS1580 Test-Method 481.5

Results from the raft at HMAS STIRLING fulfil the requirements of AS1580, test-method 481.5 investigated in this study; namely,

a. that settlement of the larvae of the fouling organisms takes place throughout the year (para 2.5 of method), and

b. that the surface temperature of the water is above 15°C and below 25°C for not less than eight months of the year (para 2.6).

The major organisms at the raft site were bryozoans, barnacles, tubeworms and bivalve molluscs and as such the community resembles that described in procedure 2 of the test method. Settlement intensity is lower at HMAS STIRLING than in the example given from Garden Island, Sydney [1]. However, settlement is sufficiently intense (Table 1) for the HMAS STIRLING raft to be a suitable test site.

In addition to the six major species, a wide variety of fouling organisms settled at the raft site (Table 2). Test materials will therefore be subjected to a range of fouling types. In particular, the high algal settlement is important as these species can exhibit high resistance to antifouling coatings [2].

4.2 Comparison of 1978/79 Settlement with 1979/80

Settlement counts from the trial conducted by HMAS STIRLING during 1978/79 (Table 3) were markedly lower than those during 1979/80 (Table 1). Several explanations could account for these differences :

(i) larval settlement in Careening Bay during 1978/79 was lower than during 1979/80,

(ii) the abundance of established fouling on the raft was less in 1978/79 than in 1979/80 and as a result less larvae were available for settlement on test panels, and

(iii) grey, unsandblasted PVC panels are a less favourable substrate for settlement than black, sandblasted PVC panels.

Evidence in support of the third explanation was gained from the last panel of the 1978/79 series which was immersed adjacent to, and for the same period as the first panel of the 1979/80 series. For all six major species, settlement counts were lower on the grey than on the black panel (Tables 1, 3). Without further trials, it remains uncertain as to whether the colour or the texture of the panels was the prime cause of the difference. However, the extent of the variation in settlement between the two substrates prevents any valid comparison of results from 1978/79 with those from 1979/80.

The abundance of established fouling on the raft would have been lower in 1978/79, when the raft was newly immersed, than in 1979/80. Waters around the raft are, however, in open connection with Careening Bay and fouling growth is plentiful elsewhere in the Bay. The contribution of fouling on the raft to the overall abundance of planktonic larvae available for settlement would appear to be negligible when compared to that contributed by the fouling on other structures. The effects of raft fouling would therefore be unlikely to cause significant variation in settlement rates at the raft site.

4.3 Community Development

Although a range of fouling organisms settled at the raft site throughout the study period, characteristics of the individual species determine which dominate the community after a specified period of immersion. The first species to dominate are those with rapid settlement and fast growth rates; typified in the present study by the green and brown algae (Figure 3). With increased immersion time larger slower growing species are able to displace the earlier colonists and prevent their further settlement.

Details on the development of fouling communities at HMAS STIRLING were obtained during a three-year study of fouling beneath the Submarine Wharf [3,4]. This study also examined the establishment and general characteristics of fouling at the site.

5. CONCLUSION

The raft at HMAS STIRLING meets the requirements of Australian Standard 1580, test-method 481.5 with regards to water temperature variations and settlement of marine fouling. The abundance and variety of fouling organisms are sufficiently high for the raft to be a suitable test site for underwater coatings.

6. ACKNOWLEDGEMENTS

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TABLE 1

ABUNDANCE OF THE SIX MOST NUMEROUS FOULING ORGANISMS
DURING THE STUDY PERIOD

Organism	Settlement Count (Individuals/m^2) Period Ending (1979-80)											
	28/6	28/7	28/8	28/9	29/10	30/11	28/12	29/1	28/2	*	28/4*	29/5
Balanus spp. (Barnacles)	400	5 700	3 900	2 100	5 300	10 700	1 700	6 000	18 900	(21 000)	46 700 (25 600)	108 500
Janua pagenstecheri (Quatrefages) (Tubeworm)	900	300	900	6 400	9 400	28 700	55 100	6 500	200	-	-	-
Mytilus edulis Linnaeus (Bivalve)	5 000	400	20 300	6 400	400	2 300	200	-	-	-	-	-
Bugula stolonifera Ryland (Bryozoan)	1 400	200	200	-	-	3 400	500	-	6 700	(1 800)	2 300 (500)	100
Pileolaria militaris Claparède (Tubeworm)	1 000	700	3 200	300	2 600	1 100	100	900	200	(100)	400 (300)	500
Bugula neritina (Linnaeus) (Bryozoan)	1 600	-	-	-	-	-	1 900	-	2 400	(3 000)	4 100 (1 100)	-

* Panel immersed for 2 months. See text for the derivation of monthly figures given in parentheses.

TABLE 2

NUMBER OF SPECIES (N) OF EACH OF THE PRINCIPAL GROUPS OF FOULING ORGANISMS IDENTIFIED DURING THE STUDY

Group	n	Group	n
Green algae	4	Bivalve molluscs	2
Brown algae	3	Barnacles	3
Red algae	11	Erect bryozoans	2
Sponges	1	Encrusting bryozoans	6
Hydroids	1	Solitary ascidians	1
Tubeworms	4	Colonial ascidians	5

TABLE 3

ABUNDANCE OF THE SIX MOST NUMEROUS FOULING ORGANISMS

Organism	Settlement Count (Individuals/m^2) Period Ending (1978-79)										
	28/8	28/9	30/10	28/11	28/12	30/1	28/2	30/3	1/5	29/5	28/6
Mytilus edulis (Bivalve)	54 300	400	100	-	-	-	-	-	-	-	-
Balanus spp. (Barnacles)	200	300	-	-	200	2 000	2 000	500	33 500	8 600	100
Bugula stolonifera (Bryozoan)	-	-	-	100	-	100	-	-	6 900	8 700	200
Janua pagenstecheri (Tubeworm)	100	-	-	400	1 800	-	-	1 500	200	100	-
Pileolaria militaris (Tubeworm)	-	-	100	400	800	100	-	600	400	-	100
Bugula neritina (Bryozoan)	-	-	-	-	-	-	-	-	400	600	700

TABLE 4

BIOMASS OF FOULING AFTER 12 MONTHS

Organism	Biomass (Wet Wt.) g/panel	
	Panel 1	Panel 2
Mytilus edulis (Bivalve)	4 240	850
Monia ione (Bivalve)	703	750
Ascidians	35	635
Barnacles	91	207
Bryozoans	10	38
Other	negligible	negligible
Total	5 079	2 480

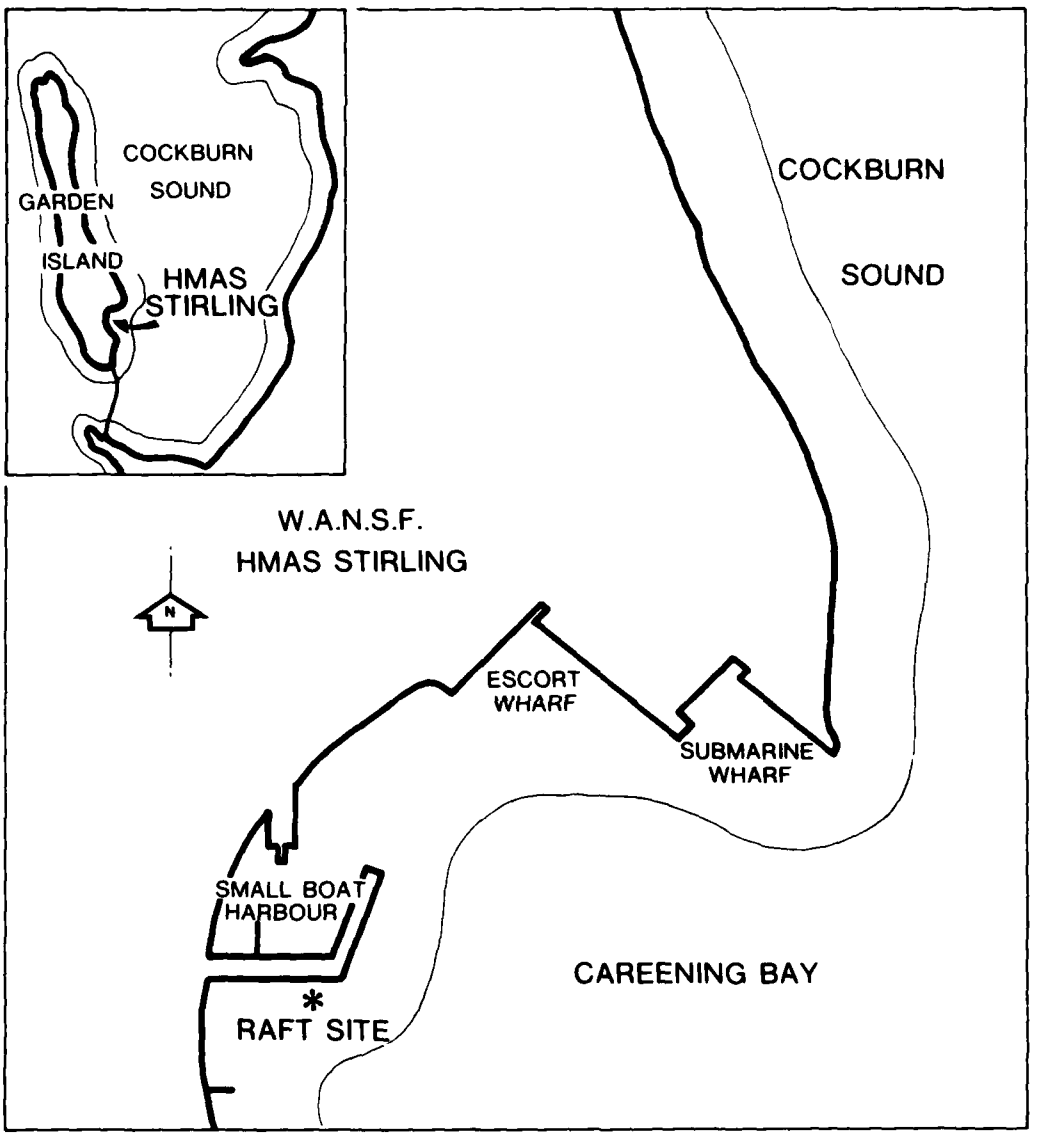

FIG. 1 - Location of the raft at HMAS STIRLING.

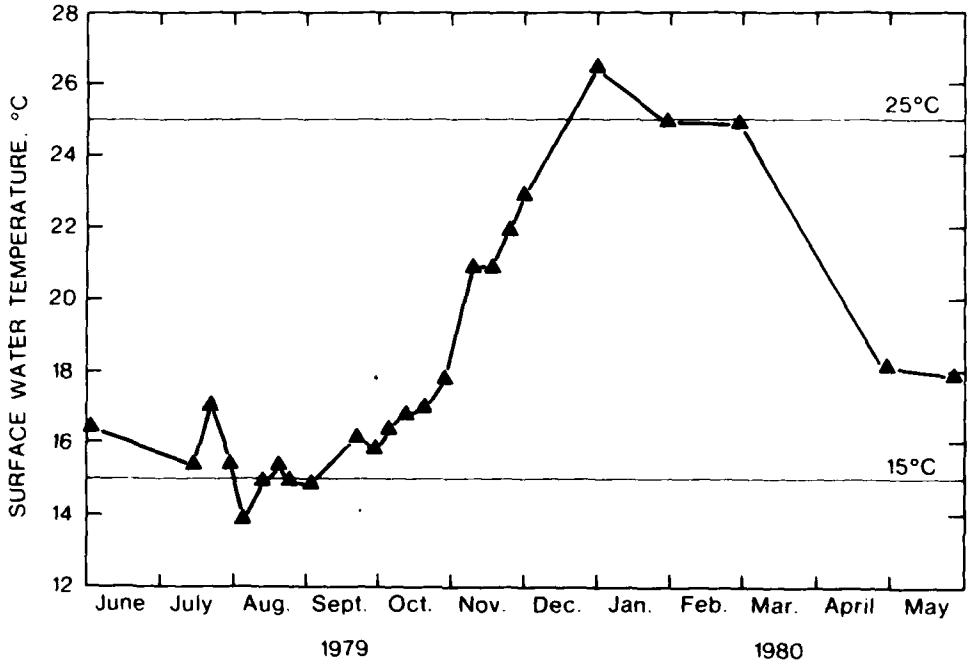

FIG. 2 - Variation in surface water temperature at the raft site.

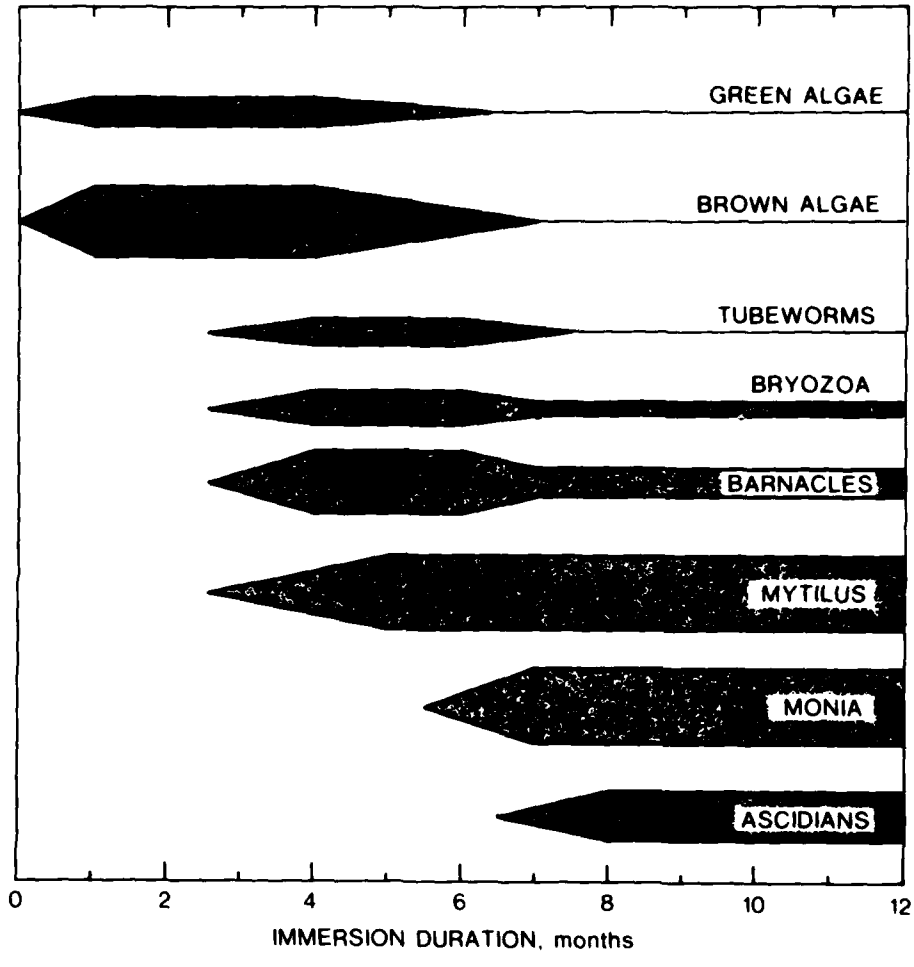

FIG. 3 - Variation in abundance of the major fouling organisms with increased time on panels immersed continuously for twelve months. (Abundance values based on percentage cover estimates by HMAS STIRLING personnel).

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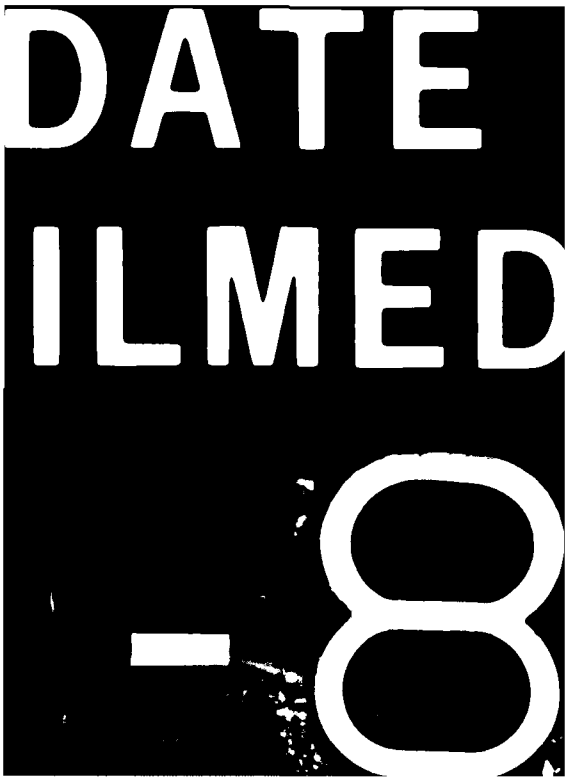
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